EXD. Index

Vol. 7. Nos. 3 and 4. September and December, 1950.

THE QUEENSLAND JOURNAL OF AGRICULTURAL SCIENCE

COMMONWEALTH INST. ENTOMOLOGY LIBRARY
31 MAR 1952
SERIAL Aus. 40
SEPARATE

CONTENTS

PAGE.

Seasonal Variations in the Composition of Milk. By L. E. NICHOLS and F. G. FEW 49

The Effect of Formalin on Leptospirae in Calf Urine. By G. C. SIMMONS 80

PUBLISHED QUARTERLY

By the Queensland Department of Agriculture and Stock, Brisbane

Issued by Direction of Hon. H. H. COLLINS,
Secretary for Agriculture and Stock.

EDITORIAL BOARD.

Chairman and Editor: C. W. WINDERS, B.Sc.Agr., A.C.I.S.

A. L. CLAY, B.V.Sc., Assistant Director, Division of Animal Industry;

J. LEGG, B.Sc., D.V.Sc., M.R.C.V.S., Director of Research, Division of Animal Industry;

E. B. RICE, Dip.Ind.Chem., Director of Dairying, Division of Dairying;

J. H. SIMMONDS, M.B.E., M.Sc., Officer in Charge, Science Branch, Division of Plant Industry;

W. J. S. SLOAN, M.Sc.Agr., Assistant Director of Agriculture, Agriculture Branch, Division of Plant Industry;

J. H. SMITH, M.Sc., N.D.A., Assistant Director, Horticulture Branch, Division of Plant Industry;

A. K. SUTHERLAND, B.V.Sc., M.S., Senior Veterinary Pathologist, Division of Animal Industry;

L. G. VALLANCE, M.Sc., Assistant Director, Bureau of Sugar Experiment Stations, Division of Plant Industry;

M. WHITE, M.Sc., Ph.D., A.A.C.I., Agricultural Chemist and Biochemist, Chemical Laboratory, Division of Plant Industry.

The Journal is supplied free of charge to organisations and institutions engaged in agricultural science or veterinary science. Applications should be made to the Under Secretary, Department of Agriculture and Stock, Brisbane, Queensland, Australia.

THE QUEENSLAND JOURNAL OF AGRICULTURAL SCIENCE

VOL. 7. Nos. 3 and 4.

SEPTEMBER and DECEMBER, 1950

SEASONAL VARIATIONS IN THE COMPOSITION OF MILK.

By L. E. NICHOLS, B.Sc.Agr., A.R.A.C.I. (Director of Research), and
F. G. FEW, B.Sc., B.Sc.App., (Dairy Technologist), Division of Dairying.

SUMMARY.

1. The chemical composition of milk from herds of various breeds on eight farms within the Brisbane milk supply area was determined at intervals over periods ranging from 12 months to 30 months.

2. Wide seasonal variations occurred in the constituents determined. The most conspicuous deterioration in composition was recorded in the late winter and early spring months, when pastures were poor.

3. Composition varied with breed. A Jersey herd yielded the highest mean percentages of total solids, fat, solids-non-fat, total protein and casein, and a Friesian herd the lowest percentages of these constituents.

4. Morning milk was consistently lower in fat percentage than evening milk because of the longer milking interval.

5. It is deduced from butterfat records of cows in numerous herd recording units, and from seasonal variations in the cheese yielding capacity of milk supplied to cheese factories, that the trends in composition noted apply in all or most dairying districts in Queensland.

6. The evidence suggests that variation in milk composition is due largely to changes in the nutritive value of pastures.

INTRODUCTION.

A noticeable decline in the fat content of the mixed herd milk from many farms during the late winter and early spring months has been a matter of concern to milk pasteurisation factories in Brisbane. Factories usually receive only the morning milk, and as the milking intervals on the farm are commonly 10 and 14 hours, the milk received from many farms fails to reach the legal minimum fat percentage of 3·3 at certain times of the year. The cheese yielding capacity of milk received at Queensland cheese factories also shows seasonal variation.

Information has been published on the results of investigations carried out overseas on seasonal variations in the composition of milk, but apparently no comprehensive study of variations extending over a long period has been made previously in Australia.

This paper records the variations in the composition of the milk from eight farms within the Brisbane milk supply area during the period March 1947 to August 1949. The properties selected were representative milk-producing farms. The breeds of cattle on the farms included in the survey were Jersey, Australian Illawarra Shorthorn, Friesian, Ayrshire, Guernsey and crosses of these breeds.

SEASONAL CONDITIONS AND FARMING METHODS.

During the period of the investigation, seasonal conditions were generally favourable and better than average. Good crops and pastures were evident on all the farms at most times and the dairy cattle were in good condition throughout. Concentrates were fed to all herds, in some cases throughout the year, in others, for four months over the winter period. Farm practices remained virtually unaltered throughout the period of the investigation.

While there is a general tendency for comparatively dry winter months to be experienced in the Brisbane milk supply area, with July and August the driest, the rainfall for these two months was lower than the mean during each year of the investigation. Rainfall totals for 1947 were, however, much above the long-term means for the districts concerned. The heaviest rainfall in each year occurred, as is usual, during the summer months of December to March. The low incidence of winter and early spring rainfall and the reliance normally placed on permanent pastures (principally the summer-growing paspalum) justify the assumption that the level of animal nutrition is generally lower during this period than during the summer months. Official rainfall recordings are given in Table 1.

Mean screen temperatures recorded at the Weather Bureau during the period of the investigation are given in Table 2. Monthly mean maximum temperatures during the winter months approximated to 70° F. and only over limited summer periods did the mean maximum temperature reach 84° F.

Table 1.

RAINFALL DATA (IN INCHES) FOR VARIOUS STATIONS.

Station.	Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Whole Year.
*Samford	1947	11·11	14·44	12·20			Not available							
	Mean, 20 years	5·34	5·53	5·05	3·91	2·04	2·12	1·85	·89	1·96	2·36	3·50	4·88	39·43
Beaudesert ..	1947	..	..	11·59	2·96	1·31	·50	·20	·47	2·47	2·08	3·31	9·79	55·85
	1948	3·26	2·40	2·84	2·60	7·10	8·03	1·00	·69	3·48	Nil	2·27	3·57	37·24
	1949	2·82	14·11	6·88	·48	·69	3·24	1·09	0·43	1·18	8·35	3·78	3·68	46·73
	Mean, 50 years	5·21	4·80	3·94	2·41	1·99	2·08	1·62	1·23	1·77	2·48	3·11	4·42	35·06
Sherwood ..	1947	..	..	10·39	4·90	1·64	·36	·20	·34	2·89	2·72	2·86	9·51	55·54
	1948	4·09	3·61	2·65	4·01	5·40	8·04	·39	1·27	3·32	Nil	1·02	2·96	36·76
	1949	3·81	9·11	9·46	·50	1·18	3·11	·52	·06	1·88	8·75	2·76	2·98	44·12
	Mean, 44 years	5·29	4·98	4·74	2·93	2·42	2·13	1·72	1·18	1·62	2·27	3·31	4·30	36·89
Brisbane	1947	..	..	11·24	6·54	2·18	·29	·34	·50	2·93	3·66	2·80	8·14	60·30
	1948	4·78	3·30	6·13	4·15	4·90	8·83	·53	1·35	2·98	·03	1·35	3·21	41·44
	1949	5·17	6·81	7·54	·63	1·68	2·95	·82	·20	2·07	11·47	4·52	3·48	47·28
	Mean, 96 years	6·34	6·28	5·71	3·69	2·73	2·54	2·14	1·86	1·99	2·60	3·74	5·09	44·75
Bald Hills ..	1947	..	..	10·10	6·80	2·60	·28	·13	·59	4·27	2·79	5·48	10·87	67·64
	1948	3·30	3·27	6·49	4·39	8·42	9·98	·62	2·16	2·38	·04	1·96	2·62	45·63
	1949	3·25	8·71	8·56	2·58	1·54	3·62	1·35	·14	1·70	13·01	3·99	3·79	52·47
	Mean, 47 years	5·84	6·03	5·86	3·42	2·77	2·51	1·88	1·20	1·67	2·61	3·41	4·93	42·14
†Beenleigh ..	1947	..	..	13·01	6·63	2·56	·30	·53	·58	2·55	2·73	2·85	10·33	72·39
	1948	3·25	2·17	7·93	4·67	7·19	12·61	·39	2·09	3·44	Nil	1·38	1·42	46·54
	1949	2·86	13·29	12·75	1·35	2·16	2·96	·68	·20	1·56	10·91	3·55	2·81	55·17
	Mean, 66 years	6·41	6·62	6·29	4·46	3·63	2·86	2·29	1·85	1·98	2·55	3·54	5·01	47·49
‡Lake Manchester	1947	..	..	6·66	1·95	1·97	·36	·23	·40	2·44	2·89	2·02	9·30	45·33
	1948	4·52	2·36	4·49	3·55	5·84	6·59	·64	·61	3·30	·03	1·26	4·15	37·34
	1949	2·83	9·27	10·26	·34	1·59	3·97	·64	·08	1·11	6·02	2·02	1·96	43·50
	Mean, 25 years	5·03	4·03	4·33	2·70	1·80	2·21	1·75	·95	1·21	2·14	2·98	4·15	33·28

* Nearest station to Camp Mountain. † Nearest station to Logan Village. ‡Nearest station to Brookfield.

Table 2.

SCREEN TEMPERATURE DATA FOR BRISBANE.

Year.	——	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Year.
		°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
1947	Mean..	77·8	74·5	74·7	70·0	65·6	60·2	58·3	61·1	65·3	67·7	70·9	74·8	68·4
	Mean Maximum ..	84·8	80·6	81·3	78·2	73·5	71·2	70·1	70·6	74·0	76·4	78·6	82·6	76·8
	Mean Minimum ..	70·8	68·5	68·0	61·8	57·7	49·2	46·4	51·5	56·5	59·1	63·2	67·0	60·0
1948	Mean..	73·7	75·9	75·1	68·3	63·6	60·0	58·2	61·5	64·7	70·7	73·5	75·9	68·4
	Mean Maximum ..	81·8	83·1	82·7	76·8	73·5	68·7	71·6	74·6	81·3	82·0	83·4	77·4	78·0
	Mean Minimum ..	65·7	68·8	67·5	59·9	53·7	51·3	47·7	51·4	54·8	60·2	65·0	68·3	59·5
1949	Mean..	76·4	78·0	74·1	67·7	63·3	58·2	57·9	59·7	64·1	71·3	72·8	74·5	68·1
	Mean Maximum ..	84·3	85·2	80·0	76·1	72·8	66·9	68·3	70·2	73·4	79·1	80·7	83·6	76·7
	Mean Minimum ..	67·9	70·8	68·1	59·2	54·2	49·5	47·4	49·2	54·9	63·6	64·8	66·5	59·7
62 years	Mean..	77·2	76·5	74·4	70·1	64·6	60·3	58·6	60·7	65·1	69·7	73·3	76·1	68·9
	Mean Maximum ..	85·3	84·3	82·3	78·8	73·6	69·3	68·5	71·3	75·4	79·1	82·3	84·7	77·9
	Mean Minimum	69·1	68·6	66·4	61·4	55·6	51·1	48·7	50·1	54·8	60·0	64·3	67·4	59·8

Some observers, including Regan and Richardson (1938), have noted an effect of atmospheric temperature on milk yield, and some (e.g., Wright (1946)) believe that European breeds of cattle are not adapted to conditions where the mean annual temperature exceeds 70° F. The results of this investigation, however, are in keeping with the observations of Riek and Lee (1948), who showed that butterfat and milk production are not affected in Jersey cows exposed intermittently to temperatures ranging from 85° to 110° F.

Particulars of calvings for each herd over its test period show that the number of calvings each month was reasonably uniform throughout the year. Uniform monthly calving of cows is a common practice among farmers who supply market milk as opposed to seasonal (spring-early summer) calving on farms producing cream for supply to butter factories.

METHODS.

Sampling.

The milk produced on each of the farms was sampled once monthly during the first year by experienced field officers who were given explicit instruction in sampling procedure. The date of sampling differed from farm to farm but was approximately the same each month for individual farms.

During the second year and part of the third year, only alternate monthly sampling was possible. Two of the farms were not able to participate in the investigations for the full two-and-a-half years, but were limited to periods of 12 months and 16 months respectively. All relevant local data likely to affect the composition of milk were recorded by the field officer at the time of sampling.

Separate samples of night and morning supply were taken. After being filled, each can of milk was thoroughly stirred and an aliquot portion placed in a bulk sample bottle. Where the night's milk was separated, a drip sample was collected from the milk vat outlet during the entire milking period. The one-pint samples were preserved by the addition of six drops of formalin.

Analytical.

In the tabulated results, values are given for the following constituents:— Total solids, fat, total protein, casein, lactose, and solids-not-fat. Direct determinations were made in the case of total solids, fat, total protein, non-casein protein, and lactose. The value for solids-not-fat was obtained by subtracting the fat from the total solids; the casein is the difference between non-casein protein and total protein.

The analytical methods used in the direct evaluations are summarised hereunder:—

Total Solids.—The Quevenne lactometer method was employed, using the H. Droop Richmond formula:—

$$\text{Total Solids} = 0{\cdot}25 \text{ lactometer reading} + 1{\cdot}2 \text{ fat} + 0{\cdot}14.$$

Fat.—The fat was determined by the Babcock method (Burgess, 1936).

Total Protein.—The Kjeldahl-Gunning digestion method (Association of Official Agricultural Chemists, 1945), using pure reagents, was employed. From the percentage of nitrogen obtained, the protein was calculated by multiplying by 6·38.

Lactose.—The Lane and Eynon method modified by McDowell (1941) was used for this determination.

Non-Casein Protein.—The casein was precipitated from the diluted aliquot at pH 4·7 and the contents of the flask filtered. A nitrogen determination was made on the clear filtrate and the non-casein protein calculated from it by using the factor 6·38.

RESULTS AND DISCUSSION.

Mean Composition of Milk.

Table 3 shows the mean composition of the milk from each herd over the periods indicated. These results were obtained by multiplying the number of gallons of milk by the percentages found analytically, for both morning and evening milk, and then dividing each sum of products by the total number of gallons.

Table 3.

MEAN COMPOSITION OF MILK FROM EACH HERD.

Herd.	Total Solids.	Fat.	Solids-Not-Fat.	Total Protein.	Casein.	Lactose.
Jersey (Sherwood)						
March 1947–February 1948 ..	14·2	5·0	9·2	3·47	2·61	4·35
Friesian (Samford)						
March 1947–June 1948	11·8	3·5	8·3	2·77	1·98	4·24
A.I.S. (Beaudesert)						
March 1947–August 1949	12·6	3·8	8·8	3·04	2·26	4·34
Jersey/A.I.S. (Beaudesert)						
March 1947–August 1949	13·1	4·3	8·9	3·07	2·39	4·29
Guernsey (Logan Village)						
March 1947–August 1949	13·0	4·2	8·8	3·11	2·42	4·27
A.I.S. (Bald Hills)						
May 1947–August 1949	13·1	4·1	8·9	3·12	2·34	4·36
Ayrshire (Brookfield)						
March 1947–August 1949	12·6	3·9	8·7	2·98	2·24	4·30
Ayrshire (Camp Mountain)						
March 1947–August 1949	12·4	3·8	8·6	2·99	2·25	4·29

The composition over the period of the investigation varied widely with the breed of the herd. Fat and total solids showed the greatest variation, while lactose was the least variable milk constituent. The Jersey herd gave milk with the highest percentage of total solids, fat, solids-not-fat, total protein and casein, while the milk of the Friesian herd was lowest in these constituents. Much smaller differences were found in the mean values for the constituents of the milk of the remaining herds. At the request of the owners, the investigation was discontinued after 12 months in the case of the Jersey herd, and after 16 months in the case of the Friesian herd.

Monthly Variations in Milk Composition.

Tables 4-11 show the mean composition of the milk of each herd each month (or alternate month) calculated simply by totalling the morning and evening monthly results for each constituent and dividing by the total number of gallons. The variation in composition is clearly discernible from the graphical representation of these tables (Figures 1-6).

The range of variation in the main milk constituents from month to month is shown at the foot of each table.

Table 4.

MONTHLY VARIATIONS IN THE COMPOSITION OF MILK.

Jersey Herd (Sherwood).

Month.	No. of Cows.	No. of gallons per day.	Total Solids.	Fat.	Total Protein.	Casein.	Lactose.
			%	%	%	%	%
1947—							
March	15	29	14·0	5·2	3·41	2·59	4·36
April	15	25	14·6	5·6	3·70	2·76	4·29
May	9	19	15·6	6·2	3·75	2·88	4·34
June	9	18	14·6	5·4	3·91	3·00	4·33
July	9	17·5	15·1	5·5	4·00	3·07	4·25
August	12	35·5	14·2	4·7	3·43	2·64	4·20
September	15	46	13·9	4·6	3·31	2·53	4·40
October	14	50	14·2	5·0	3·35	2·50	4·48
November	16	43	13·6	4·6	3·26	2·41	4·30
December	17	42	14·1	4·9	3·35	2·52	4·29
1948—							
January	17	40	13·7	5·1	3·47	2·67	4·47
February	14	33	14·7	5·1	3·50	2·52	4·34
Range	..	..	13·6 to 15·6	4·6 to 6·2	3·26 to 4·00	2·41 to 3·07	4·20 to 4·48

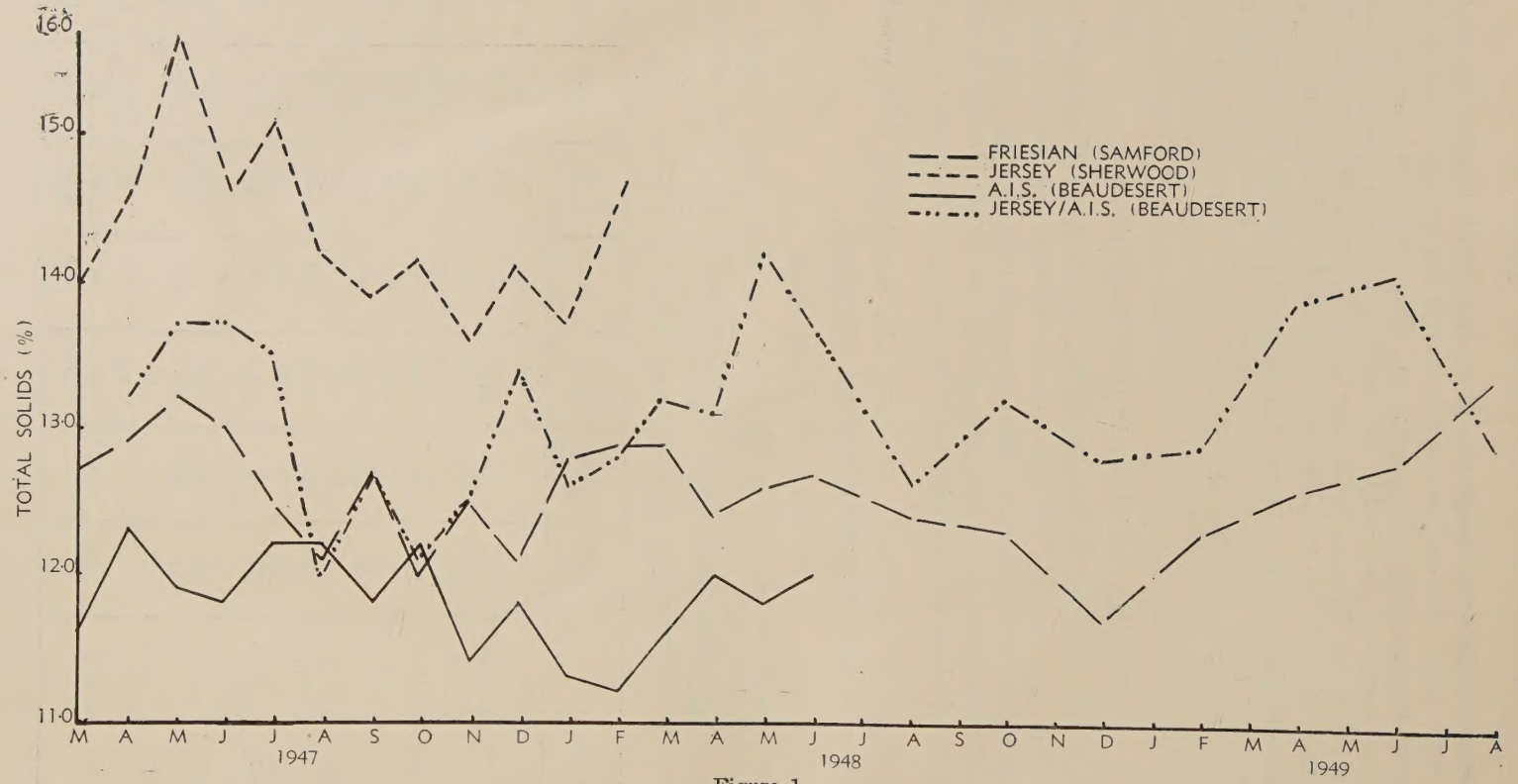

Figure 1.

Monthly Variations in Total Solids for Friesian, Jersey, A.I.S. and Jersey/A.I.S. Herds.

The general trend of the seasonal variation in milk composition was similar irrespective of the herd under consideration. The trends in fat, total solids, solids-not-fat, casein and total protein were similar. All tended to be lowest during the dry late winter and early spring months. Fat and total solids showed the widest variation; total protein and casein varied less widely. Lactose varied least of the constituents determined; it did not vary directly with the fat, but the tendency was for higher lactose percentages to accompany lower percentages of fat.

Milk supplied during the early winter months was generally of better compositional quality than that received during the warmer months, the percentage of each solid constituent, with the exception of lactose, being broadly inversely proportional to the yield of milk. Lactose was usually lower in winter and higher in summer.

Summarising, the results show that milk composition deteriorated sharply after the drier and colder months of July and August. This was seemingly related to the poor condition of the pastures. The hand feeding of concentrates largely practised at this time of the year on each farm stimulated production

Table 5.

MONTHLY VARIATIONS IN THE COMPOSITION OF MILK.

Friesian Herd (Samford).

Month.	No. of Cows.	No. of gallons per day.	Total Solids.	Fat.	Total Protein.	Casein.	Lactose.
1947—			%	%	%	%	%
March	22	35	11·6	3·3	2·85	1·98	4·19
April	22	29·5	12·3	3·8	3·03	1·97	4·38
May	21	32·5	11·9	3·5	3·02	2·08	4·15
June	23	34·0	11·8	3·5	2·90	1·97	4·31
July	18	19·0	12·2	3·7	2·75	2·02	4·17
August	21	28·5	12·2	3·8	2·67	1·96	4·09
September	21	26·5	11·8	3·7	2·79	1·95	4·31
October	15	18·0	12·2	3·8	2·65	1·91	4·29
November	12	15·5	11·4	3·4	2·59	1·87	4·16
December	17	23	11·8	3·5	2·69	1·94	4·34
1948—							
January	19	32	11·3	3·1	2·81	2·11	4·45
February	18	29	11·2	2·9	2·54	1·75	4·34
March	18	25·5	11·6	3·3	2·57	1·76	3·96
April	19	22·5	12·0	3·7	2·77	1·98	4·20
May	18	24	11·8	3·4	2·83	2·10	4·26
June	16	20	11·9	3·7	2·73	1·92	4·13
Range	..	..	11·2 to 12·3	2·9 to 3·8	2·54 to 3·03	1·75 to 2·11	3·96 to 4·45

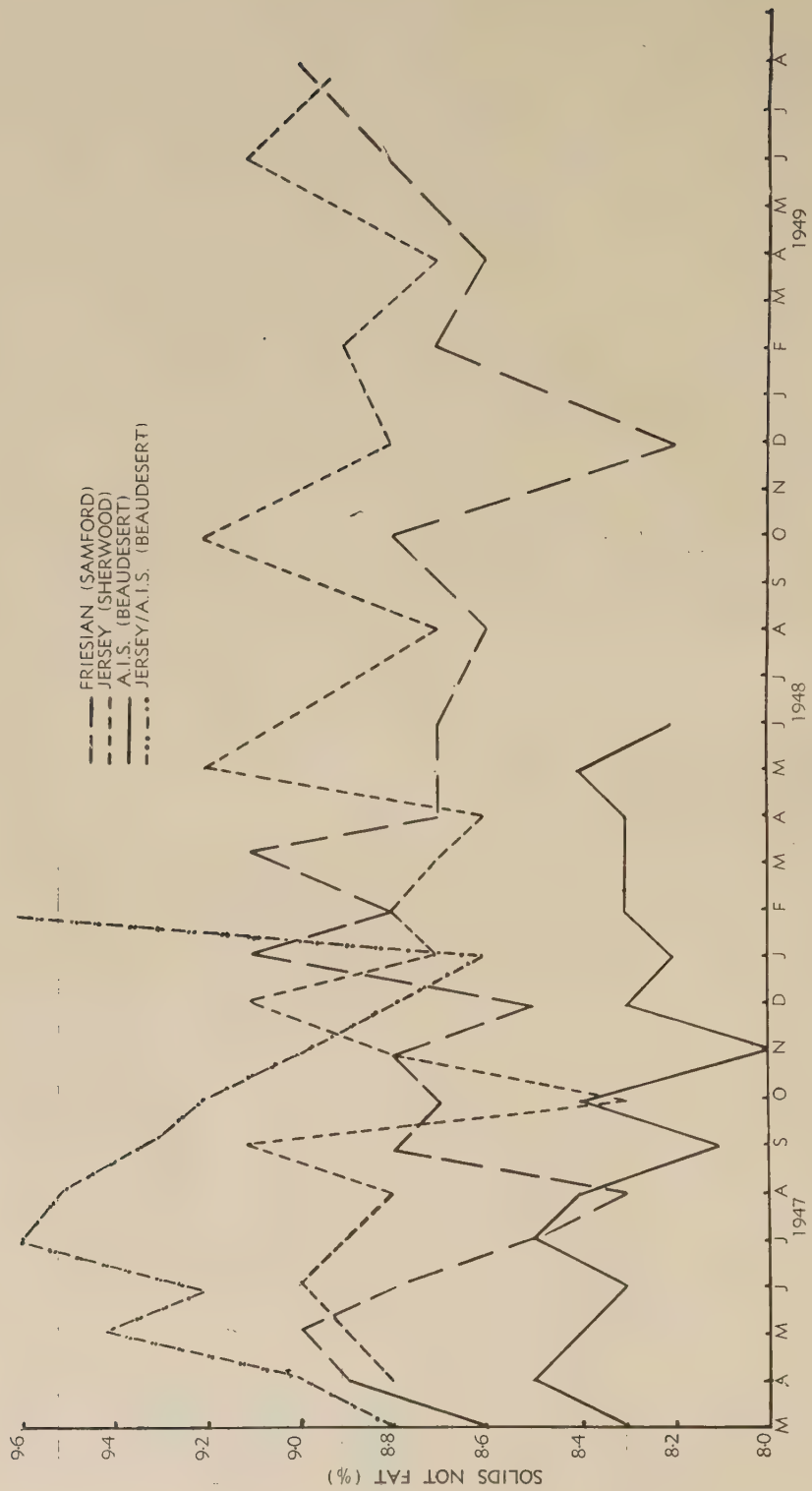

Figure 2.

Monthly Variations in Solids-not-fat for Friesian, Jersey, A.I.S. and Jersey/A.I.S. Herds.

Table 6.

MONTHLY VARIATIONS IN THE COMPOSITION OF MILK.
Australian Illawarra Shorthorn Herd (Beaudesert).

Month.	No. of Cows.	No. of gallons per day.	Total Solids.	Fat.	Total Protein.	Casein.	Lactose.
1947—			%	%	%	%	%
March	73	115	12·7	4·1	3·23	2·41	4·50
April	72	117	12·9	4·0	3·29	2·42	4·29
May	78	105	13·2	4·2	3·26	2·45	4·48
June	80	98	13·0	4·2	3·32	2·35	4·24
July	71	75	12·5	4·0	2·96	2·21	4·20
August	68	72	12·1	3·8	3·00	2·27	4·28
September	60	77	12·7	3·9	3·03	2·30	4·39
October	60	81	12·0	3·3	2·91	2·19	4·26
November	65	86	12·5	3·7	2·86	2·12	4·35
December	65	85	12·1	3·6	2·77	2·06	4·32
1948—							
January	68	115	12·8	3·7	3·17	2·41	4·58
February	73	108	12·9	4·1	3·00	2·28	4·58
March	67	100	12·9	3·8	2·95	2·08	4·19
April	68	108	12·4	3·7	2·99	2·16	4·37
May	73	88	12·6	3·9	2·89	2·17	4·19
June	73	88	12·7	4·0	3·21	2·39	4·35
August	62	85	12·4	3·8	3·06	2·24	4·24
October	63	86	12·3	3·5	3·06	2·25	4·40
December	61	72	11·7	3·5	2·66	1·95	4·20
1949—							
February	60	79	12·3	3·6	3·03	2·32	4·14
April	69	88	12·6	4·0	3·13	2·45	4·27
June	62	79	12·8	4·0	2·99	2·29	4·40
August	70	88	13·4	4·4	2·96	2·30	4·50
Range	..	..	11·7 to 13·4	3·3 to 4·4	2·66 to 3·32	1·95 to 2·45	4·14 to 4·58

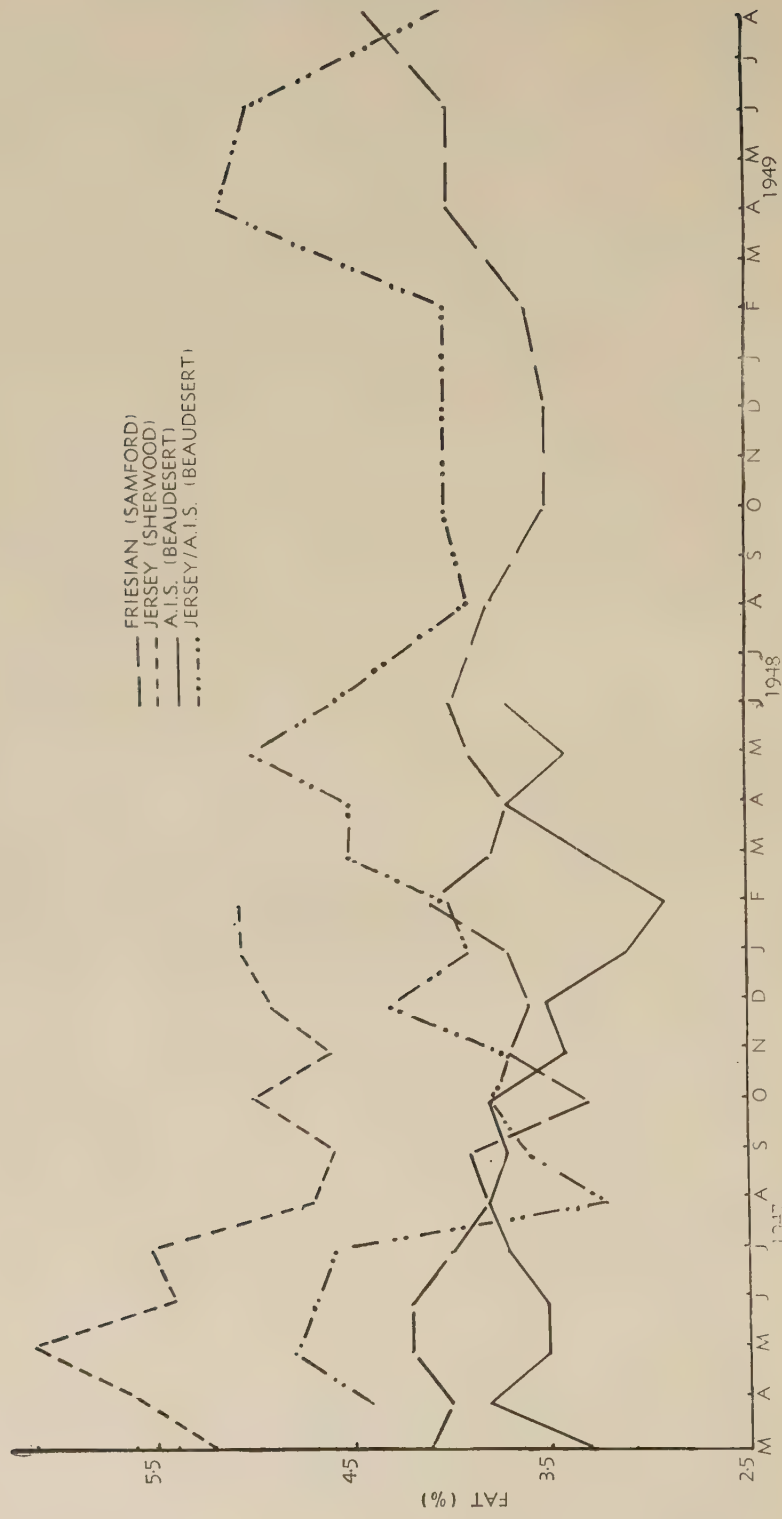

Figure 3.

Monthly Variations in Fat for Friesian, Jersey, A.I.S. and Jersey/A.I.S. Herds.

Table 7.

MONTHLY VARIATIONS IN THE COMPOSITION OF MILK.
Mixed Jersey and A.I.S. Herd (Beaudesert).

Month.	No. of Cows.	No. of gallons per day.	Total Solids.	Fat.	Total Protein.	Casein.	Lactose.
1947—			%	%	%	%	%
April	35	33	13·2	4·4	3·27	2·53	4·48
May	25	19	13·7	4·8	3·36	2·61	4·32
June	21	16	13·7	4·7	3·36	2·68	4·20
July	22	15·5	13·5	4·6	3·21	2·50	4·05
August	22	15·5	12·0	3·2	3·10	2·46	4·43
September	29	51	12·7	3·6	2·97	2·33	4·34
October	27	34	12·1	3·8	2·74	2·12	4·45
November	42	52	12·5	3·7	2·83	2·21	4·25
December	51	81	13·4	4·3	2·83	2·13	4·57
1948—							
January	48	71	12·6	3·9	3·00	2·42	4·58
February	51	41	12·8	4·0	2·82	2·07	4·15
March	47	39	13·2	4·5	3·25	2·46	4·08
April	28	15	13·1	4·5	3·20	2·46	4·23
May	24	30	14·2	5·0	3·60	2·84	4·30
August	20	23	12·6	3·9	3·17	2·29	4·13
October	20	29	13·2	4·0	3·16	2·41	4·20
December	34	43	12·8	4·0	2·94	2·27	4·18
1949—							
February	42	43	12·9	4·0	2·95	2·34	4·25
April	43	39	13·9	5·2	3·16	2·49	4·28
June	25	21	14·1	5·0	3·20	2·51	4·28
August	24	25	12·9	4·0	2·98	2·37	4·35
Range	..	..	12 to 14·2	3·2 to 5·2	2·74 to 3·60	2·07 to 2·84	4·05 to 4·58

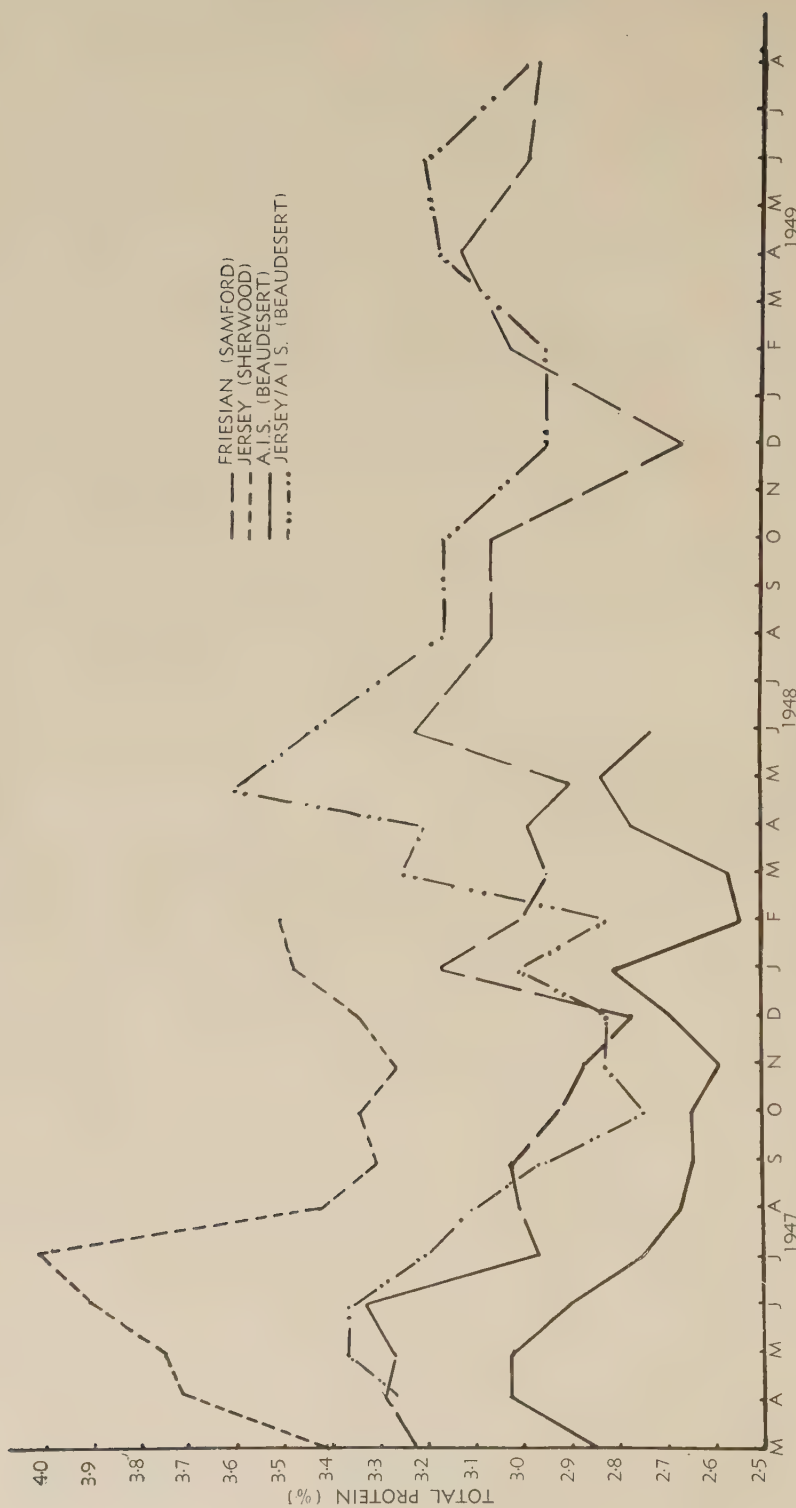

Figure 4.

Monthly Variations in Total Protein for Friesian, Jersey, A.I.S. and Jersey/A.I.S. Herds.

Table 8.

MONTHLY VARIATIONS IN THE COMPOSITION OF MILK.
Guernsey Herd (Logan Village).

Month.	No. of Cows.	No. of gallons per day.	Total Solids.	Fat.	Total Protein.	Casein.	Lactose.
1947—			%	%	%	%	%
March	15	19	12·9	4·4	3·22	2·44	4·55
April	14	20	13·4	4·3	3·35	2·61	4·50
May	39	32	13·8	4·8	3·55	2·74	4·23
June	31	22	13·8	4·8	3·42	2·71	4·29
July	31	16	13·3	4·6	3·24	2·50	4·16
August	25	22	12·6	3·9	3·13	2·44	4·34
September	27	26	12·7	3·9	2·99	2·33	4·52
October	26	42	12·6	3·8	2·90	2·28	4·46
November	..	31	12·8	3·9	2·95	2·33	4·39
December	42	63	12·7	3·9	3·02	2·25	4·36
1948—							
January	53	86	13·0	4·1	3·02	2·42	4·44
February	50	90	12·5	3·8	3·02	2·38	4·20
March	40	65	13·1	4·3	3·25	2·47	4·00
April	43	65	13·2	4·3	3·11	2·44	4·23
May	40	45	12·8	4·2	3·15	2·49	4·28
June	36	45	13·1	4·3	3·21	2·50	4·22
August	20	36	12·1	3·6	2·81	2·18	4·47
December	50	58	11·6	3·2	2·65	1·94	4·09
1949—							
February	37	47	13·1	4·3	3·27	2·63	4·16
April	37	33	14·2	5·0	3·59	2·93	4·17
June	37	43	14·0	4·8	3·47	2·68	4·24
August	21	30	12·4	3·7	2·75	2·14	4·45
Range	..	..	11·6 to 14·2	3·2 to 5·0	2·65 to 3·59	1·94 to 2·93	4·00 to 4·55

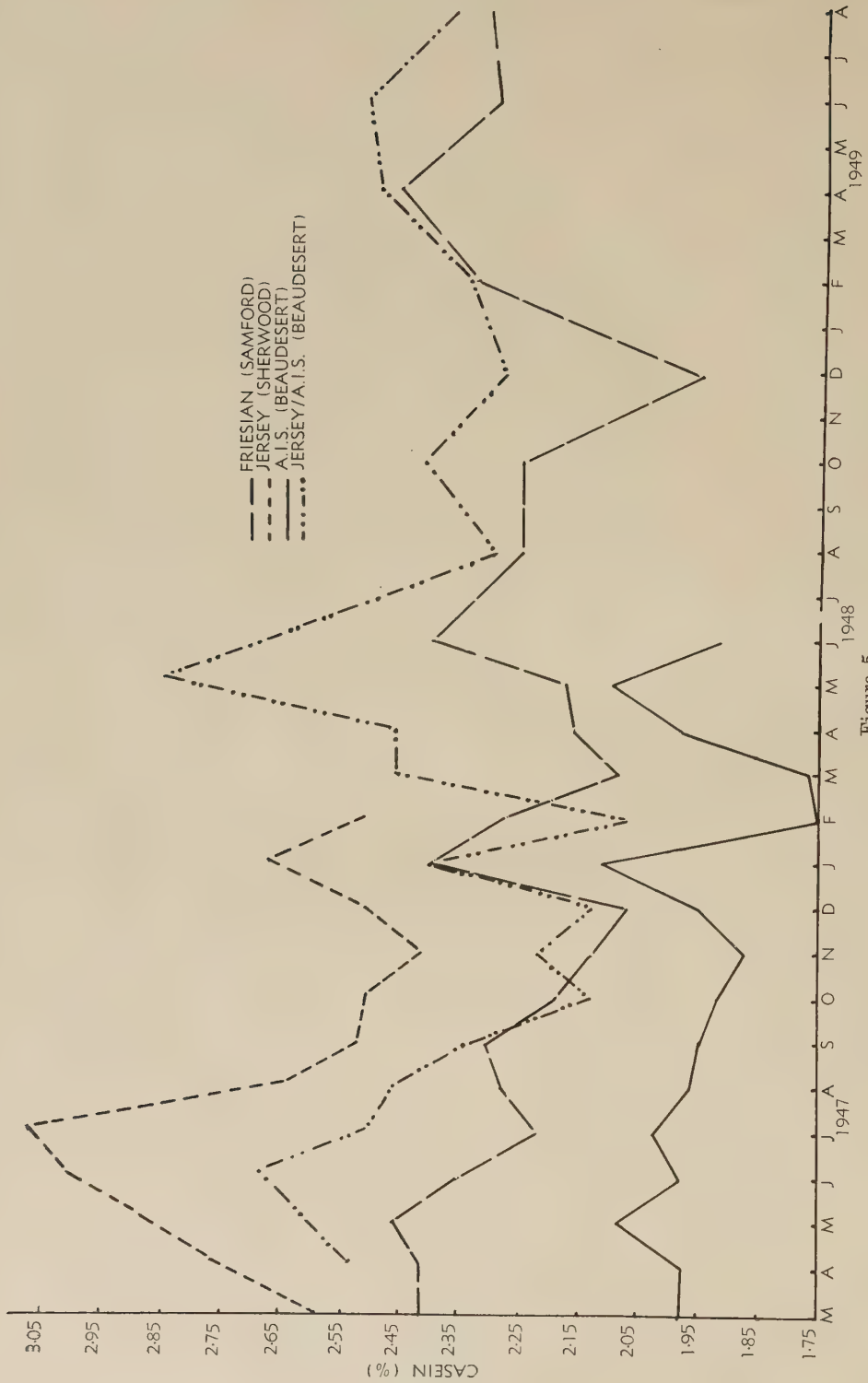

Figure 5.

Monthly Variations in Casein for Friesian, Jersey, A.I.S. and Jersey/A.I.S. herds.

Table 9.

MONTHLY VARIATIONS IN THE COMPOSITION OF MILK.
Australian Illawarra Shorthorn Herd (Bald Hills.)

Month.	No. of Cows.	No. of gallons per day.	Totals Solids.	Fat.	Total Protein.	Casein.	Lactose.
1947—			%	%	%	%	%
March	62	94	12·5	3·7	3·17	2·44	4·61
April	67	96	13·1	4·2	3·24	2·41	4·46
May	67	75	13·6	4·6	3·30	2·47	4·57
June	67	66	13·6	4·7	3·35	2·44	4·43
July	66	77	13·1	4·3	3·19	2·46	4·30
August	65	79	13·1	4·1	3·16	2·43	4·21
September	67	75	13·6	4·7	3·23	2·46	4·37
October	65	91	13·8	4·4	3·42	2·61	4·47
November	58	76	13·2	4·1	3·17	2·31	4·32
December	50	86	13·2	4·3	3·18	2·30	4·37
1948—							
January	59	97	13·1	4·2	3·22	2·40	4·47
February	60	99	13·0	3·9	3·07	2·29	4·59
March	54	84	13·3	4·2	3·03	2·26	4·32
April	..	71	13·4	4·5	3·14	2·37	4·21
May	65	87	13·4	4·5	3·12	2·35	4·26
June	67	88	13·0	4·2	3·17	2·41	4·40
August	..	63	12·3	3·7	2·91	2·20	4·31
October	55	88	12·7	3·9	3·10	2·22	4·36
December	50	61	12·3	3·8	2·86	2·13	4·19
1949—							
February	56	63	12·4	3·8	2·94	2·14	4·28
April	58	80	13·8	4·6	3·17	2·46	4·38
June	65	65	12·9	4·1	3·14	2·35	4·25
August	50	48	12·6	4·0	2·91	2·19	4·36
Range	..	..	12·3 to 13·8	3·7 to 4·7	2·86 to 3·42	2·13 to 2·61	4·19 to 4·61

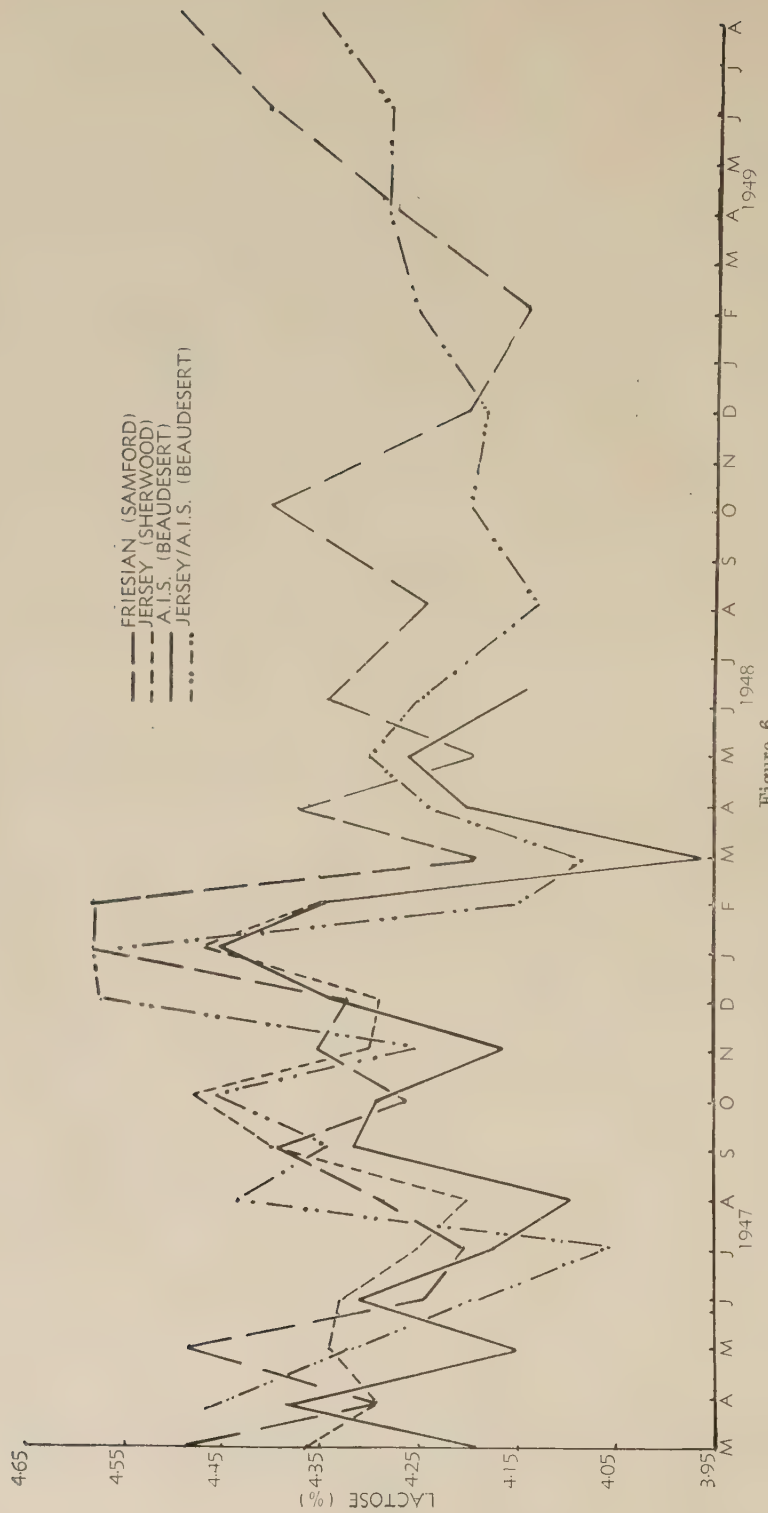

Figure 6.

Monthly Variations in Lactose for Friesian, Jersey, A.I.S. and Jersey/A.I.S. Herds.

Table 10.

MONTHLY VARIATIONS IN THE COMPOSITION OF MILK.
Ayrshire Herd (Brookfield).

Month.	No. of Cows.	No. of gallons per day.	Total Solids.	Fat.	Total Protein.	Casein.	Lactose.
1947—			%	%	%	%	%
May	24	34	12·8	4·1	3·18	2·31	4·38
June	19	24	12·5	3·8	2·93	2·22	4·25
July	19	19	12·6	4·2	2·93	2·08	4·13
August	..	..	..	..	..	..	..
September	20	19·5	12·1	3·9	2·93	2·28	4·34
October	20	25	12·8	4·3	3·07	2·37	4·37
November	21	20	12·8	3·7	2·87	2·11	4·43
December	19	24	12·3	4·2	2·80	2·13	4·20
1948—							
January	24	40	12·6	3·7	2·97	2·25	4·63
February	..	..	..	..	..	..	..
March	22	45	12·7	4·1	3·06	2·20	3·78
April	14	20	12·7	3·8	3·22	2·47	4·30
May	11	14	13·1	4·5	3·04	2·31	4·18
June	14	16	13·4	4·6	3·12	2·42	4·48
August	17	22	12·1	3·4	2·91	2·26	4·48
October	12	16	12·6	4·0	3·02	2·20	4·37
December	22	18	12·3	4·0	3·12	2·27	3·98
1949—							
February	23	24	12·8	4·2	3·03	2·24	4·19
April	16	19	13·1	4·1	3·12	2·34	4·27
June	16	14	12·5	3·9	2·67	2·04	4·47
August	16	15	11·9	3·1	2·61	2·00	4·45
Range	..	..	11·9 to 13·4	3·1 to 4·6	2·61 to 3·22	2·00 to 2·47	3·78 to 4·63

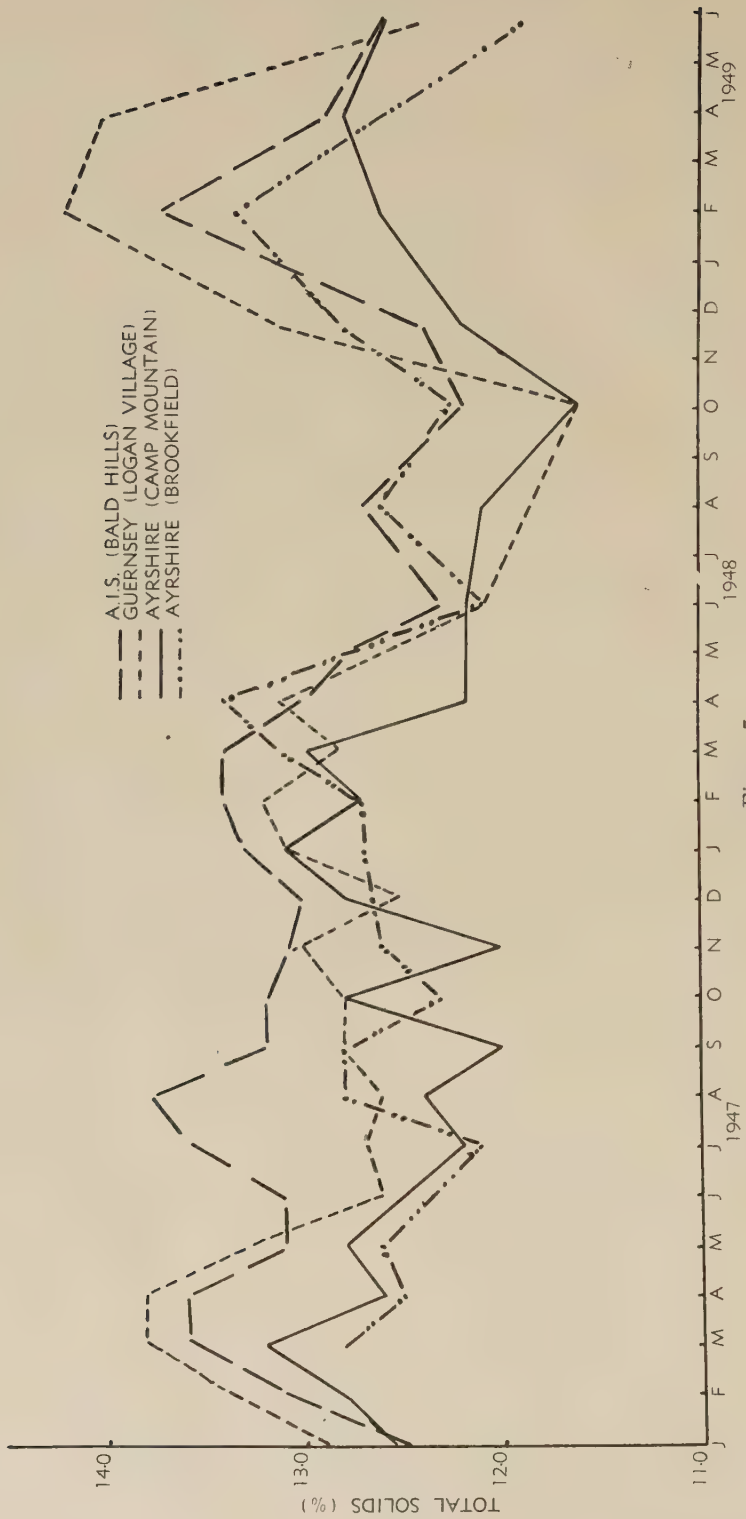

Figure 7.

Monthly Variations in Total Solids for A.I.S., Guernsey and Ayrshire Herds.

Table 11.

MONTHLY VARIATIONS IN THE COMPOSITION OF MILK.
Ayrshire Herd (Camp Mountain.)

Month.	No. of Cows.	No. of gallons per day.	Total Solids.	Fat.	Total Protein.	Casein.	Lactose.
1947—			%	%	%	%	%
March	48	87	12·6	3·9	3·04	2·30	4·41
April	45	84	12·8	3·9	3·22	2·41	4·43
May	41	63	13·2	4·4	3·22	2·41	4·37
June	38	67	12·6	4·0	3·21	2·31	4·40
July	33	58	12·8	4·3	3·02	2·23	3·96
August	34	57	12·4	3·9	2·90	2·19	4·05
September	32	55	12·2	3·8	2·94	2·10	4·25
October	26	51	12·4	3·7	2·93	2·13	4·30
November	45	57	12·0	3·8	2·97	2·21	4·10
December	44	56	12·6	4·0	2·94	2·16	4·24
1948—							
January	40	73	12·0	3·8	2·98	2·23	4·46
February	44	67	12·8	4·1	3·22	2·44	4·40
March	42	63	13·1	4·0	2·98	2·15	4·24
April	46	53	12·7	3·9	3·20	2·46	4·36
May	46	56	13·0	4·1	3·14	2·40	4·28
June	51	74	12·2	3·6	2·95	2·21	4·30
August	45	54	12·2	3·7	2·82	2·12	4·29
October	32	59	12·1	3·6	2·90	2·09	4·35
December	32	65	11·6	3·2	2·86	2·16	4·06
1949—							
February	36	83	12·2	3·4	2·86	2·13	4·21
April	29	69	12·6	4·0	3·09	2·41	4·15
June	40	52	12·8	4·0	3·09	2·32	4·29
August	50	62	12·6	3·7	2·83	2·14	4·57
Range	..	..	11·6 to 13·2	3·2 to 4·4	2·82 to 3·22	2·09 to 2·46	3·96 to 4·57

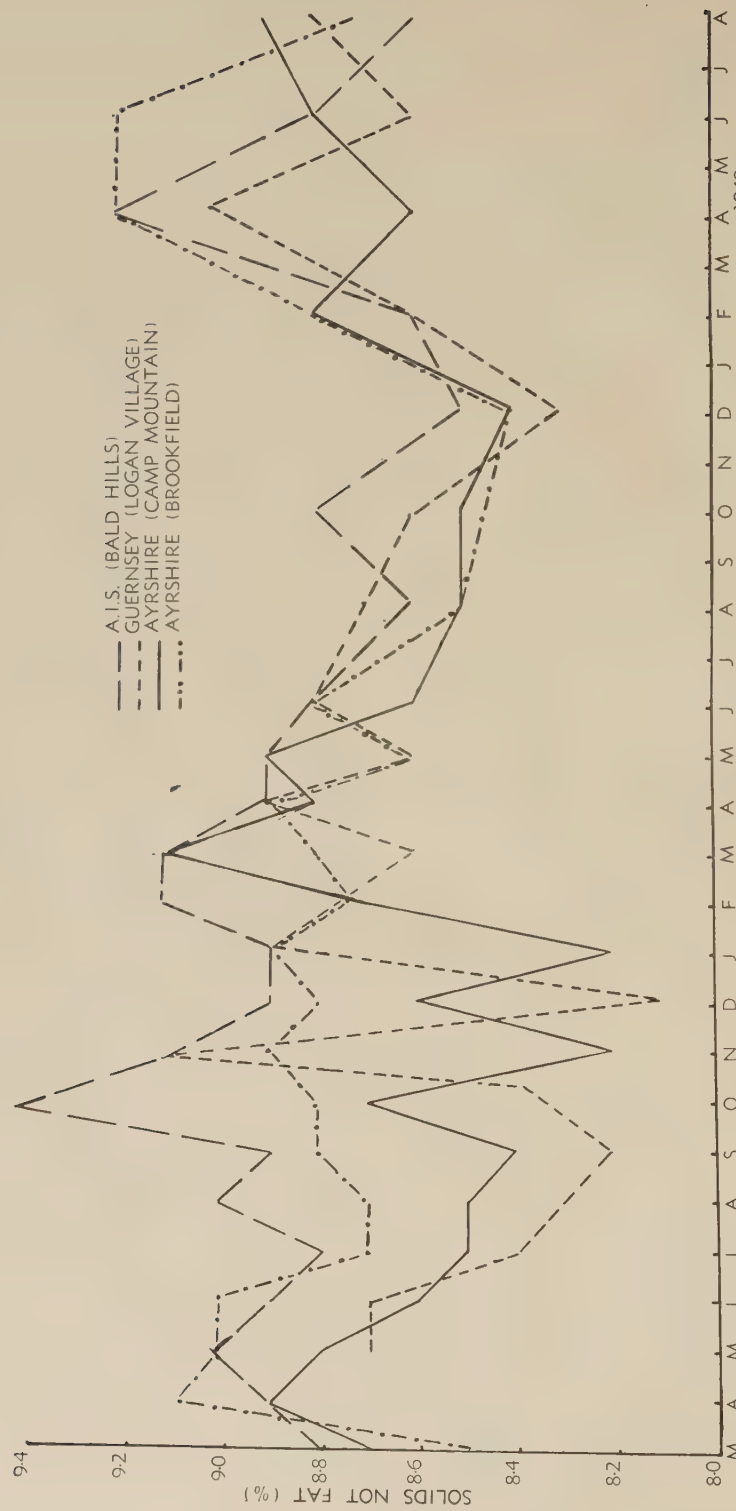

Figure 8.

Monthly Variations in Solids-not-fat for A.I.S., Guernsey and Ayrshire Herds.

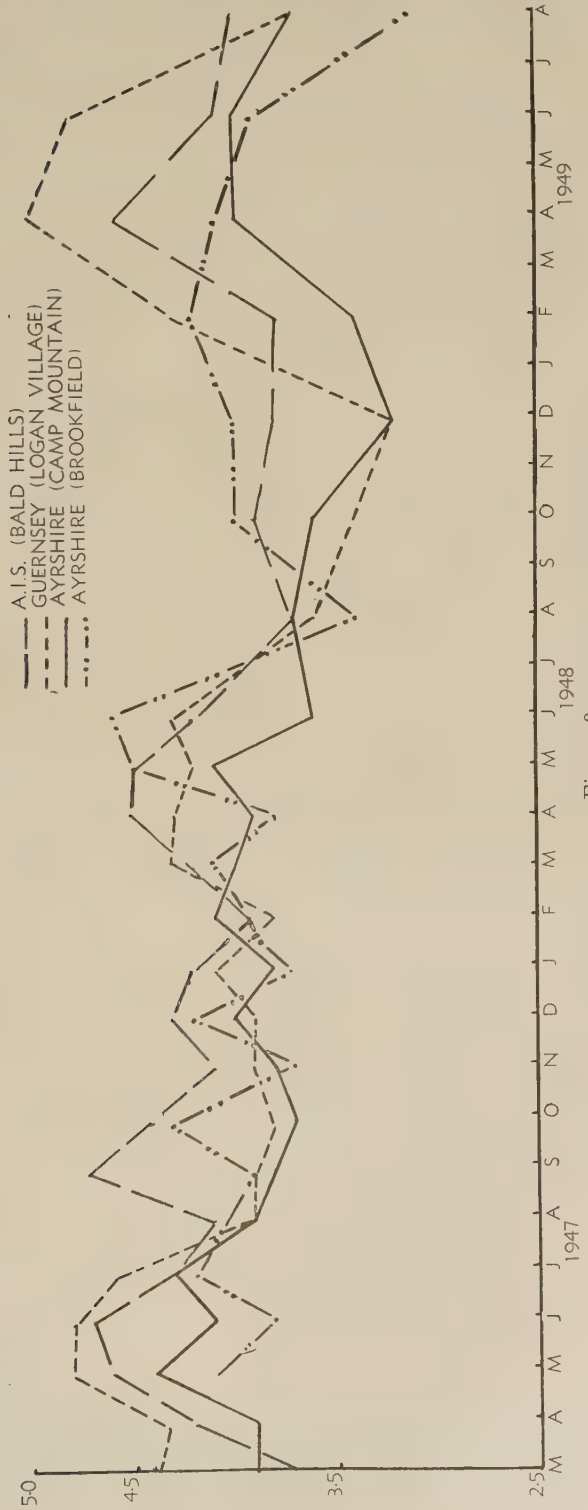
A.I.S. (BALD HILLS)
GUERNSEY (LOGAN VILLAGE)
AYRSHIRE (CAMP MOUNTAIN)
AYRSHIRE (BROOKFIELD)
5·0
4·5
3·5
2·5
M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A
1947
1948
1949

Figure 9.

Monthly Variations in Fat for A.I.S., Guernsey and Ayrshire Herds.

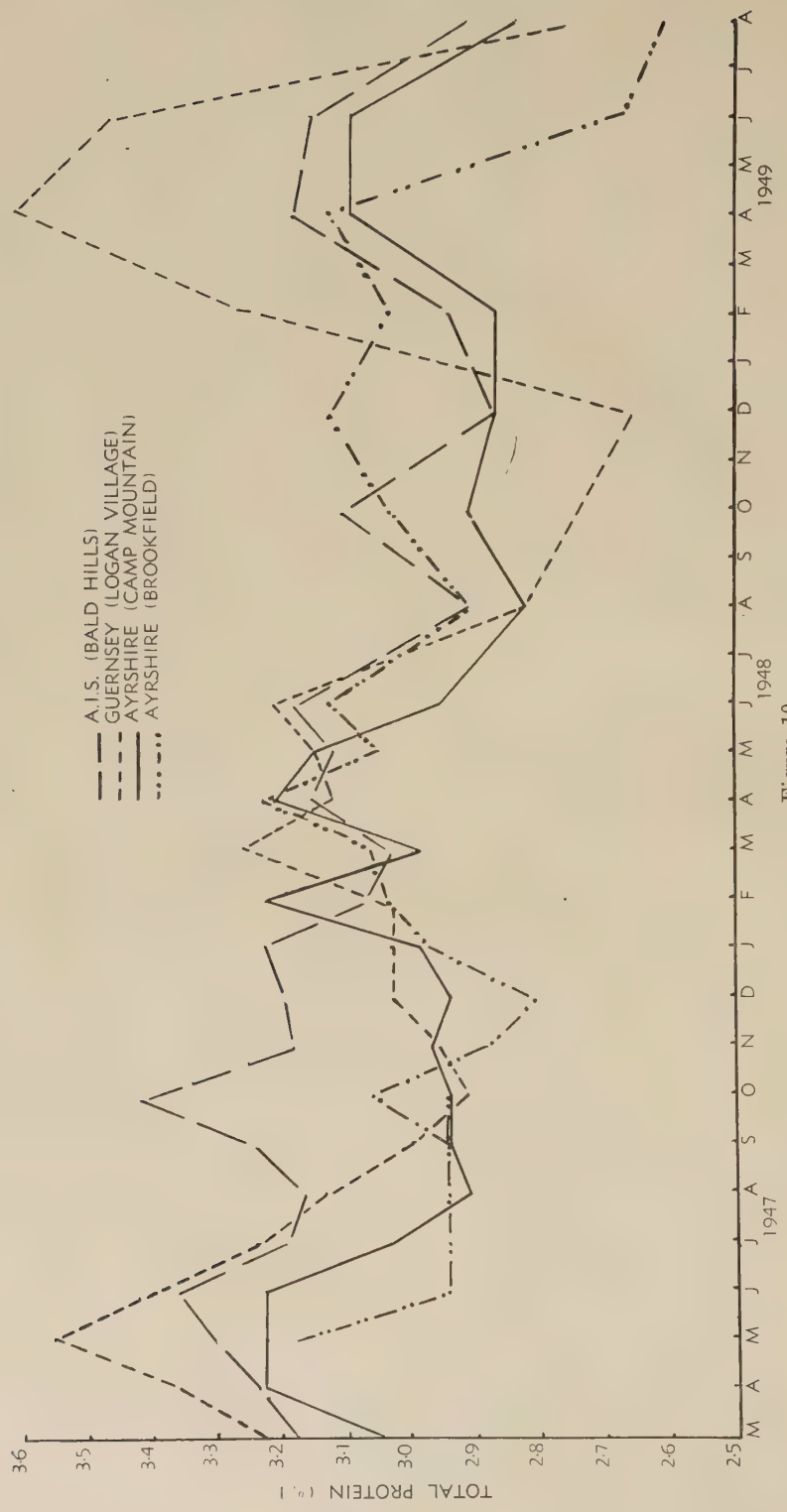

Figure 10.

Monthly Variations in Total Protein for A.I.S., Guernsey and Ayrshire Herds.

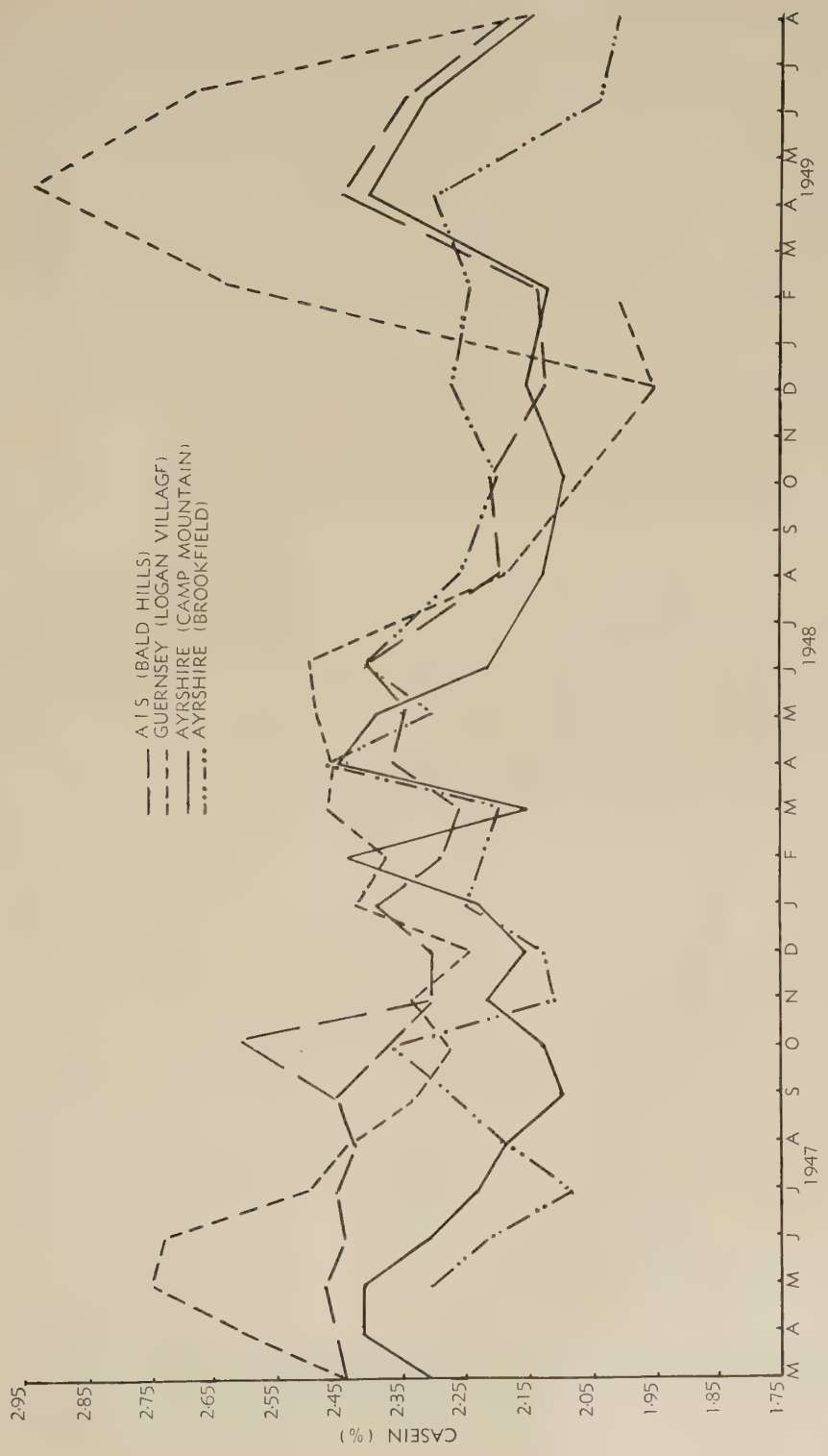

Figure 11.

Monthly Variations in Casein for A.I.S., Guernsey and Ayrshire Herds.

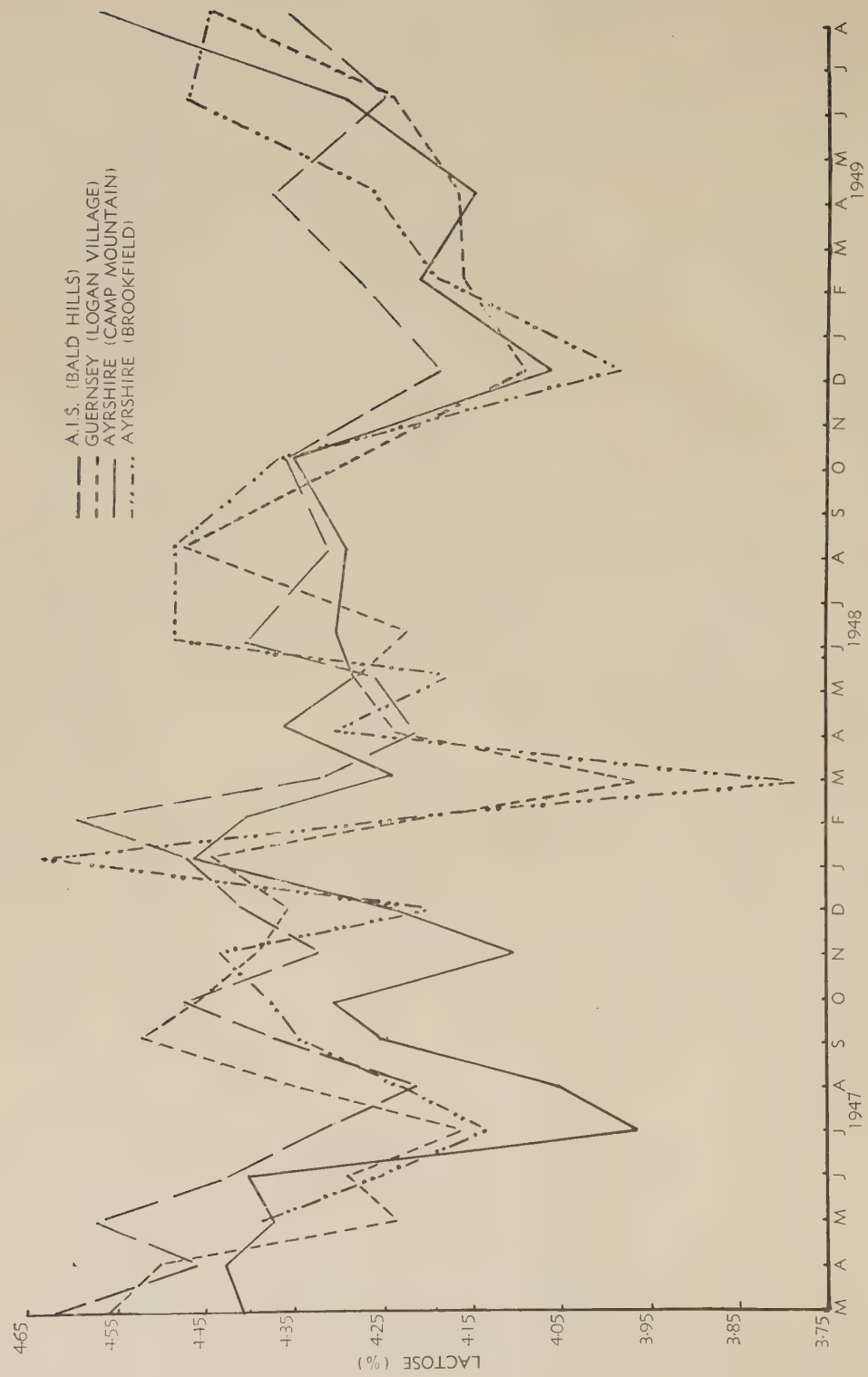

Figure 12.

Monthly Variations in Lactose for A.I.S., Guernsey and Ayrshire Herds.

but did not materially improve composition. Over the warmer months an improvement was noticeable, but the percentages of most solid constituents did not reach a peak until the autumn and early winter months.

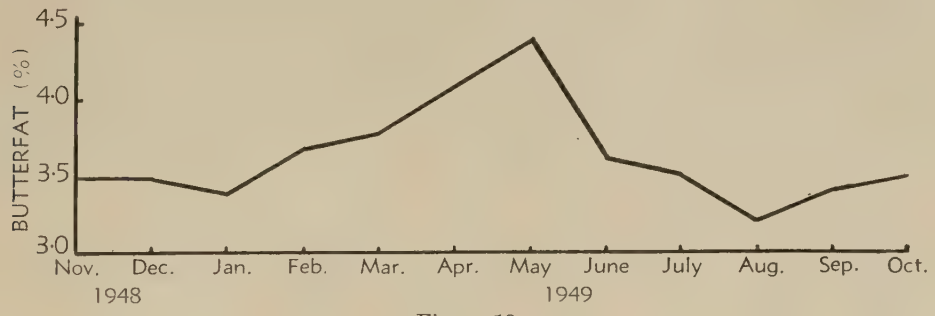

Figure 13.

Mean Monthly Fat Variation for Eight Cows which Calved in October.

Effect of Month of Calving.

As previously stated, the number of calvings in the herds under investigation was reasonably uniform for each month throughout the year. Although evidence is limited, Figures 13 and 14, illustrating the mean monthly fat percentage of milk from a herd of approximately 60 cows in the Beaudesert herd recording group, show that the seasonal trend in composition is not appreciably affected by the month of calving. Results from herds in which 9–12 cows calved in all months except June and July showed a similar seasonal trend in fat content.

Figure 14.

Mean Monthly Fat Variation for Eight Cows which Calved in November.

The majority of calvings in Queensland dairy herds occur in November, but the results show that the most conspicuous decline in the fat percentage occurs in the late winter and early spring months.

Effect of Milking Interval.

Though the tabulated results of the combined morning and evening milk determinations are not affected, the analyses made of both morning and evening milk show the variation resulting from the milking interval. Of all the main milk constituents, the fat seems to be the most affected. The morning milk was consistently lower in fat percentage following the longer overnight interval.

In commercial practice this disparity in the fat content is of considerable importance, as the liquid milk market is very largely supplied by morning's

Figure 15.

Mean Monthly Variation of Fat for Twenty Herds in the Beaudesert Herd Recording Group.

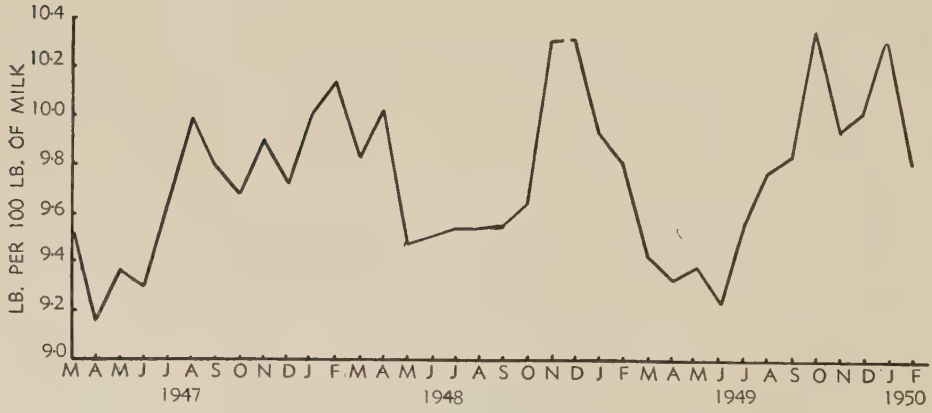

Figure 16.

Monthly Variations in the Cheese Yield for Queensland.

Table 12.

EFFECT OF THE MILKING INTERVAL ON BUTTERFAT PERCENTAGE.

Herd.	Year.	Bulk Milk.	Average Milking Interval Hours.	Mean Monthly Butterfat Percentage.											
				Mar.	Apr.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.
A.I.S.	1947–48	a.m.	15½	3·6	3·7	3·9	3·9	3·6	3·4	3·5	2·8	3·2	3·2	3·4	3·7
		p.m.	8½	5·0	4·7	4·9	5·0	4·7	4·5	4·5	4·1	4·6	4·3	4·4	4·7
	1948–49	a.m.	15	3·5	..	3·7	3·6	..	3·4	..	3·0	..	3·0	..	2·2
		p.m.	9	4·4	..	4·3	4·8	..	4·6	..	4·2	..	4·5	..	4·3
Guernsey	1947–48	a.m.	13	4·3	4·2	4·8	5·0	4·5	4·0	3·7	3·8	3·8	3·9	4·1	3·8
		p.m.	11	4·6	4·5	4·8	4·6	4·7	3·8	4·2	3·7	4·1	4·0	4·0	3·9
	1948–49	a.m.	13	3·8	..	4·0	..	..	3·6	3·1	..	..	4·1	..	4·3
		p.m.	11	3·9	..	4·4	..	..	3·9	3·4	..	..	4·6	..	4·3
Friesian	1947–48	a.m.	15	3·0	3·4	3·0	3·1	3·0	3·5	3·3	3·4	3·1	3·1	2·7	3·0
		p.m.	9	3·7	4·4	4·3	4·1	4·5	4·2	4·2	4·5	3·8	4·2	3·7	2·7
	1948–49	a.m.	15	..	3·5	..	3·3	..	..	..	..	..	..	..	..
		p.m.	9	..	4·0	..	4·2	..	..	..	..	..	..	..	..
Jersey	1947–48	a.m.	13	5·1	5·2	6·3	5·3	5·3	4·2	4·1	4·7	4·5	4·7	5·2	5·0
		p.m.	11	5·4	6·1	6·1	5·6	5·8	5·5	5·5	5·2	4·7	5·1	5·0	5·2

milk alone. The normal seasonal decline in the fat percentage of milk aggravates the already lower content of morning's milk resulting from the longer overnight milking interval.

Table 12 shows the effect of the milking interval on the fat content, the results being of analyses made during the investigation.

INFERENCES OF STATE-WIDE APPLICATION.

State-Wide Trend in Milk Composition.

As the trend in fat percentage was usually representative of the general trend of the principal milk constituents, it was used as a basis to indicate whether the composition of milk throughout Queensland followed a similar pattern to that of the herds under observation in the Brisbane district.

The results of the Beaudesert herd recording group (Figure 15), comprising 20 herds totalling approximately 800 cows, illustrate the typical decline in the fat content during the late winter and early spring months. A similar decline has been recorded in results of herds in the Grade Herd Recording Scheme in all parts of the State.

Seasonal Trend in Cheese Yields.

The cheese yielding capacity of milk also tends to follow a seasonal variation. This could be expected from the general relationship between the fat and casein content of milk and its cheese yield.

The mean monthly yield of cheese per 100 lb. milk from all cheese factories from March 1947 to August 1949 is also illustrated graphically in Figure 16. The cheese yielding capacity of milk is lowest during the winter and early spring, which is in keeping with the lower fat and casein percentages of milk at this time of the year as shown in these investigations.

CONCLUSIONS.

Because of the number of milk samples from various breeds of cows taken over the $2\frac{1}{2}$ year period from eight farms within the Brisbane milk district, the variations shown are considered to represent fairly the trend in composition of bulk milk supplied for Brisbane's market milk requirements.

Irrespective of breed, district, incidence of calving and existing feeding practices, a marked decline in the main constituents of milk occurred during the late winter and the early spring. From evidence available, this appears to apply throughout the important dairying areas of the State. The difficulty experienced by market milk interests with milk of substandard fat content during the late winter and early spring months is influenced by the seasonal variation, but is more directly the result of farm milking practice whereby the interval between night and morning milking is longer than that between morning and evening milking.

Evidence gathered from the properties concerned in this project indicates that the seasonal deterioration in the composition of milk is due not only to the lower nutritive value of the late winter and early spring pastures, but possibly also to an imbalance of roughage in the feed, as shown in New South Wales by McClymont (1950). This latter aspect is the subject of investigations now in progress.

The solution to the problem may thus be closely associated with the application of improved farm husbandry practices, aided by an alteration in farm milking procedure.

ACKNOWLEDGMENT.

It is desired to acknowledge the services of the field officers of the Brisbane Milk Board who were mainly responsible for the collection of milk samples and compilation of relevant data on the farms.

REFERENCES.

Association of Official Agricultural Chemists. 1945. Methods of analysis of the Association of Official Agricultural Chemists. Sixth Edition.

Burgess, L. A. 1936. The Babcock Test. Qld. Agric. J. 46: 633-45.

McClymont, G. L. The relation of the type and quantity of roughage and grazing to the fat content of milk. Aust. Vet. J. 26: 111-21.

McDowell, A. K. R. 1941. The estimation of lactose in milk. J. Dairy Res. 12: 131-8.

Regan, W. M., and Richardson, G. A. 1938. Reactions of the dairy cow to changes in environmental temperature. J. Dairy Sci. 21: 73-9.

Riek, R. F., and Lee, D. H. K. 1948. Reactions to hot atmospheres of Jersey cows in milk. J. Dairy Res. 15: 219-26.

Wright, N. C. 1946. Report on the development of cattle breeding and milk production in Ceylon. Ceylon Sessional Paper No. 20, Nov. 1946.

THE EFFECT OF FORMALIN ON LEPTOSPIRAE IN CALF URINE.

By G. C. SIMMONS, B.Sc., Assistant Bacteriologist, Animal Health Station (Yeerongpilly), Division of Animal Industry.

SUMMARY.

1. The effect of 0.2 per cent. and 0.5 per cent. formalin on the morphology of leptospirae in calf urine held at room temperature (21-31° C.) and at 37° C. was studied by dark-field and Fontana staining methods.

2. The morphology of the leptospirae in urine containing 0.5 per cent. formalin was not appreciably altered after five days' storage at either room temperature or 37° C.

3. Abnormal types were frequent when 0.2 per cent. formalin was used, and it was sometimes difficult to recognise organisms as leptospirae. In most cases detection of leptospirae was possible after five days' storage. This concentration of formalin did not inhibit bacterial growth on every occasion.

4. In unpreserved urine, leptospirae were on no occasion identifiable after three days' storage, and at 37° C. were only once identified after one day's storage.

5. Except for heavily contaminated urine specimens, for which both the dark-field and Fontana stain methods are advisable, dark-field illumination is preferable to Fontana staining for the detection of leptospirae.

INTRODUCTION.

During investigations of bovine leptospirosis in Queensland, it has been necessary to examine urine specimens from herds located some distance from this laboratory.

Such specimens may be as long as 48 hours in transit, when they may be exposed to the relatively high temperatures of subtropical Queensland. Under these circumstances, unless bacterial contamination is controlled, microscopic examination is difficult.

As reported by Sutherland, Simmons and Kenny (1949) one drop of formalin to 20 ml. urine was used as a preservative in specimens sent to the Animal Health Station. As this amount of formalin did not always prevent bacterial growth, and since there was a possibility that leptospirae might be destroyed by the formalin, it was decided to study the problem in more detail.

METHODS.

Urine from two naturally infected female calves was collected in sterile 1 lb. screw-capped jars, micturition being induced by digital stimulation of the vulva and adjacent skin. Contamination from the skin and hair of the vulva is unavoidable in specimens collected by this method.

The samples were divided, within three hours, into six 4 oz. sterile screw-capped jars. The three pairs were then treated as follows—one pair received sufficient formalin to make a concentration of 0·2%, the second pair a concentration of 0·5%, and the third pair served as controls. One jar from each pair was incubated at 37° C., while the other from each pair was left on the laboratory bench. Room temperature during the period of the observations varied between 21° and 31° C.

Each day for five days 10 ml. of urine from each jar was centrifuged for 45 minutes at 3,000 r.p.m. in an angle centrifuge. The supernatant was poured off and the last drop absorbed on filter paper. The deposit was then examined by (1) dark-field illumination using a Zeiss binocular microscope with 7X eye-pieces and 90X oil immersion objective, and (2) staining by Fontana's method as recommended in the Manual of Methods Leaflet (1946). Each preparation was examined for at least five minutes before being discarded as negative.

As abnormal leptospirae are often difficult to distinguish from debris which may be present in urine samples, the morphology was classified as follows (all observations carried out by one person):—

+++ = majority of organisms show hooked ends and coils.

++ = some organisms show typical morphology, but the majority have abnormal shaped ends and granular appearance.

\+ = organisms difficult to recognise as leptospirae, mainly granular forms; occasional organisms only showing coils.

The samples of urine used in Experiments 1 and 2 contained relatively few separated non-motile leptospirae. In Experiment 3, leptospirae were motile and occurred singly and in clumps. In Experiment 4 a few single motile organisms were present.

Two different batches of commercial formalin were used.

RESULTS.

The results of the four experiments are shown in Table 1, to which comments are appended.

Table 1.

RESULTS OF EXPERIMENTS.

No. of days' storage.	Stored at Room Temperature.						Stored at 37° C.					
	No formalin.		0·2% formalin.		0·5% formalin.		No formalin.		0·2% formalin.		0·5% formalin.	
	D	F	D	F	D	F	D	F	D	F	D	F
EXPERIMENT 1.												
1	−	+++	−	++	+++	+++	−	−	0	0	+	+
2	−	−	+	+	+++	+++	−	−	0	0	+	+
3	−	−	+	+	+++	+++	0	0	0	0	+	+
4	0	0	+	+	+++	+++	0	0	0	0	+	+
5	0	0	+	+	+++	++	0	0	0	0	++	+
EXPERIMENT 2.												
1	−	+++	+++	+++	++	+++	−	−	++	++	+++	+++
2	−	++	++	+++	+	+	−	−	++	++	+++	+++
3	−	−	−	−	+++	+++	0	0	+	++	++	+++
4	0	0	0	0	+++	+++	0	0	+	+	++	+++
5	0	0	0	0	+++	+++	0	0	+	++	+++	+++
EXPERIMENT 3.												
1	+++	+++	+++	+++	+++	+++	+++	+	+	++	++	+++
2	+++	++	+++	+++	+++	+++	−	−	+	++	++	++
3	−	−	+++	+++	+++	+++	−	−	++	+	++	++
4	0	0	+++	+++	+++	+++	0	0	++	+	++	++
5	0	0	+++	+++	+++	+++	0	0	++	++	++	+++

Experiment 4.

1	+++	−	+++	+++	++	+++	−	−	+	++	+++	+++
2	−	−	+++	++	+++	+++	0	0	+	++	+++	+++
3	0	0	+++	+++	+++	+++	0	0	+	+++	+++	+++
4	0	0	++	+++	++	+++	0	0	++	+++	+++	+++
5	0	0	++	++	+++	+++	0	0	++	+	+++	+++

− = no leptospirae.
0 = not done.
D = dark-field illumination.
F = Fontana stain.

Experiment 1.

The morphology of leptospirae was satisfactory for at least five days in the sample preserved with 0·5% formalin and held at room temperature. A concentration of 0·2% was unsatisfactory as the organisms were altered to such an extent that recognition was difficult. The data suggest that the Fontana stain is the best method for the examination of contaminated unpreserved specimens.

In contrast with Experiments 2, 3 and 4, 0·5% formalin did not preserve the morphology of the leptospirae at 37° C. Insufficient urine was collected to test the use of 0·2% formalin at 37° C.

Experiment 2.

Morphology was satisfactory for five days at both room temperature and 37° C. in samples containing 0·5% formalin. At room temperature 0·2% formalin did not prevent the growth of a species of *Pseudomonas*, although it did so at 37° C. However, in the latter case morphology was unsatisfactory by both the dark-field method and Fontana stain. The leptospirae were detected by staining but not by dark-field illumination in unpreserved urine held at room temperature.

Experiment 3.

Leptospirae in urine preserved with 0·2 and 0·5% formalin and held at room temperature showed satisfactory morphology, whereas the same concentrations of formalin were less satisfactory at 37° C. The ready detection in this experiment may have been due to the urine containing numerous active leptospirae.

Experiment 4.

This experiment again indicates the superiority of a concentration of 0·5% formalin, particularly if the specimen is exposed to high temperatures. In one instance, leptospirae were detected by dark-field illumination but not staining.

DISCUSSION.

If unpreserved urine is held for 1 or 2 days at room temperature or at 37° C., growth of contaminating bacteria is profuse. These organisms make the field extremely bright in the dark field method. In such cases recognition of the finer leptospirae is difficult.

The results of the four experiments indicate that 0·5% formalin is satisfactory for preserving urine containing leptospirae, but 0·2% is not; also that morphology altered more rapidly at 37° C. than at room temperature.

During the examination of these specimens containing leptospirae with both typical and atypical morphology, it was noted that the detection of the organism was easier by the dark-field method than by the staining method. In the best-stained film many of the organisms had no hooked ends and the coils were not apparent. Under these circumstances it is relatively easy to confuse leptospirae with other material present. An additional advantage of the dark-field method is the rapidity with which a number of examinations can be made once the microscope has been set up for this procedure. However, from Experiments 1, 2 and 4 it appears that both methods of examination should be used when a highly contaminated sample is submitted for examination.

REFERENCES.

Manual of Methods for Pure Culture Study of Bacteria, Leaflet IV, 9th Edition (1946).

Sutherland, A. K., Simmons, G. C., and Kenny, G. C. 1949. Bovine leptospirosis: three outbreaks in calves in Queensland. Aust. Vet. J. 25: 197-202.

CORRECTION.

Nitrite Poisoning of Pigs.

In the summary of this article, which appeared on page 1 of this volume, it was stated that certain doses of sodium nitrate produced methaemoglobinaemia. The reference should have been to doses of sodium nitrite.

INDEX.

★

PAGE.

Cotton Jassid Problem in Queensland 24

Effect of Formalin on Leptospirae in Calf Urine 80

Few, F. G. (with L. E. Nichols)—
"Seasonal Variations in the Composition of Milk" 49

Laterite—Description of a Profile near Gayndah, Queensland 15

Leptospirae in Calf Urine—Effect of Formalin 80

McDougall, W. A.—
"Rat Populations in Canefields during the Spring of 1948" 43

May, A. W. S.—
"The Cotton Jassid Problem in Queensland" 24

Milk—Seasonal Variations in Composition 49

Nichols, L. E. (with F. G. Few)—
"Seasonal Variations in the Composition of Milk" 49

Nitrite Poisoning of Pigs 1

Pigs—Poisoning by Nitrite 1

Rat Populations in Canefields during the Spring of 1948 43

Salisbury, R. M. (with W. R. Winks and A. K. Sutherland)—
"Nitrite Poisoning of Pigs" 1

Simmons, G. C.—
"The Effect of Formalin on Leptospirae in Calf Urine" 80

Sutherland, A. K. (with W. R. Winks and R. M. Salisbury)—
"Nitrite Poisoning of Pigs" 1

Teakle, L. J. H.—
"Description of a Laterite Profile near Gayndah, Queensland" 15

Winks, W. R. (with A. K. Sutherland and R. M. Salisbury)—
"Nitrite Poisoning of Pigs" 1

A. H. Tucker, Government Printer, Brisbane.

566 120164 7 104